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HEALTH AND SAFETY RESEARCH DIVISION

Environmental Restoration and Waste Management Non-Defense Programs
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**Radiological Survey Results at 4400 Piehl Road, Ottawa Lake,
Michigan (BTO002)**

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ABSTRACT

At the request of the U.S. Department of Energy (DOE), a team from Oak Ridge National Laboratory conducted a radiological survey at 4400 Piehl Road in Ottawa Lake, Michigan. The survey was performed in September, 1992. The purpose of the survey was to determine if materials containing uranium from work performed under government contract at the former Baker Brothers facility in Toledo, Ohio had been transported off-site to this neighboring area. The radiological survey included surface gamma scans indoors and outdoors, alpha and beta scans inside the house and attached garage, beta-gamma scans of the hard surfaces outside, and the collection of soil, water, and dust samples for radionuclide analyses.

Results of the survey demonstrated that the majority of the measurements on the property were within DOE guidelines. However, the presence of isolated spots of uranium contamination were found in two areas where materials were allegedly transported to the property from the former Baker Brothers site. Uranium uptake by persons on the property by ingestion is fairly unlikely, but inhalation is a possibility. Based on these findings, it is recommended that the residential property at 4400 Piehl Road in Ottawa Lake, Michigan be considered for inclusion under FUSRAP.

RADIOLOGICAL SURVEY RESULTS AT 4400 PIEHL ROAD, OTTAWA LAKE, MICHIGAN (BTO002)*

INTRODUCTION

During the early and mid-1940s, Baker Brothers, Inc., in Toledo, Ohio, fabricated uranium slugs from processed uranium metals under subcontract to the Manhattan Engineer District (MED).¹ This commercial property consisted of several buildings and grounds covered with either asphalt or concrete, except for a dirt courtyard at the northwest end of the site. Because the Baker Brothers uranium metal fabrication was apparently related to Atomic Energy Commission (AEC) activities, verification of existing conditions was needed to determine whether the site met current radiological guidelines. The principal radionuclide of concern was ^{238}U . The property was decontaminated at contract termination, and later reevaluated under the U.S. Department of Energy (DOE) Formerly Utilized Sites Remedial Action Program (FUSRAP).² In June, 1989, the preliminary radiological survey at the former Baker Brothers site (2551-2555 Harleau Place, Toledo, Ohio), was conducted by members of the Measurement Applications and Development (MAD) Group of the Oak Ridge National Laboratory (ORNL) at the request of DOE. Results of this survey indicated partial contamination with ^{238}U ,³ and the Baker property was officially included in the FUSRAP program in late 1992.

Earlier, the Baker Brothers assets were liquidated, the machinery and equipment sold at auction, and the property divided and sold to two independent companies. One part of the property was resold in the summer of 1992. The new owner contacted ORNL and inquired about the radiological status of his property. Through this conversation it was learned that soil from the former Baker Brothers site may have been moved to a site in Michigan.

During September 20-21, 1992, the MAD Group at ORNL conducted a radiological survey of 4400 Piehl Road, Ottawa Lake, Michigan at the request of the DOE, since soil had allegedly been hauled to this site from the former Baker property in Toledo, Ohio.

The property at 4400 Piehl Road in Ottawa Lake, Michigan, is in a semi-rural area approximately 15 miles northwest of Toledo, Ohio. (Fig. 1). The adjacent properties are similar in size and topography. The general area is flat and has a large number of trees. The site consists of

*The survey was performed by members of the Measurement Applications and Development Group of the Health and Safety Research Division of Oak Ridge National Laboratory under DOE contract DE-AC05-84OR21400.

approximately seven acres; one house occupied by the owner, a barn and a pond. Figures 2 through 7 are photographs of the property, and Fig. 8 is a drawing showing the current layout of this site.

The owner alleges that several dozen large dump truck loads of soil, concrete, and tree stumps were transported to his property from the former Baker Brothers site and either placed in front of his house or in a large pile behind and approximately 100 ft northwest of the house. The transported soil was readily discernable from the native soil due to its color and texture, and contained a large amount of ash, cinders and sand. It also contained heavily rusted scrap metal, brick and other debris as might be expected to be found at an industrial site. The owner also alleges that a rather large pit was dug approximately 10 ft deep at the edge of the pile. The tree stumps and the concrete slabs from the former Baker Brothers site were allegedly dumped into the pit, covered with additional soil and leveled. The pile and pit area is approximately 75 -100 ft from the pond. (see Fig. 8). Surface water drains from this area to the pond.

Two general areas are affected by the transported soil. One is a large "U" shaped area (~2200 yd²) located in front of (south) and east of the house at the edge of the existing lawn. The soil in this area has been leveled and spread, and varies in depth from a few inches to about two feet. About 10% of it has detectable surface contamination, and there may be contamination under some of the "clean" surface which is not detectable by surface measurements. The second area of transported soil (~2500 yd²), is northwest of the house, and includes a pile of soil (berm) ~5-6 feet high by ~50 ft long in the shape of an "L". The pit is located at the end of the east leg of the "L". Most of this second area has spotty contamination. The berm has the highest concentrations of uranium based on sample analyses and field measurements.

The radiological survey of this private residential property at 4400 Piehl Road, Ottawa Lake, Michigan, conducted on September 20-21, 1992, is summarized in this report.

SCOPE OF THE SURVEY

The radiological survey included: (1) a surface gamma scan of the floors of the house and attached garage, and the grounds outside the house; (2) discrete alpha measurements and beta-gamma scans of floors inside the house and attached garage, and beta scans outside on walks; (3) collection and radionuclide analysis of surface and subsurface soil samples, water samples, and material from a central vacuum cleaner.

SURVEY METHODS

A comprehensive description of the survey methods and instrumentation used in this survey is given in *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program*, ORNL/TM-8600 (April 1987).⁴

SURFACE RADIATION MEASUREMENTS

Gamma radiation levels were determined using a portable NaI gamma scintillation probe connected to a Victoreen ratemeter. Measurements were recorded and converted to $\mu\text{R/h}$. Because NaI gamma scintillators are energy dependent, measurements of gamma radiation levels in counts per minute (cpm) are normalized to pressurized ionization chamber (PIC) measurements to estimate gamma exposure rates in $\mu\text{R/h}$. Using a Geiger-Mueller pancake detector, beta-gamma radiation levels in cpm were measured over surfaces outdoors, and floor surfaces indoors, and then converted to mrad/h. Alpha levels were measured at selected locations with an ORNL alpha meter connected to a ZnS scintillation probe and then converted to dpm/100 cm².

SOIL, WATER, AND DEBRIS SAMPLING AND ANALYSIS

Surface and subsurface soil samples were systematically collected over the property. Surface and subsurface soil samples were also collected in areas of elevated gamma exposure rates. Such samples are referred to as biased samples and are more likely to contain elevated concentrations of radionuclides than are systematically chosen samples. Water samples were collected from the pond, located in the northeast quadrant of the property (Fig. 8), and from a faucet outside the house, which is supplied by a well located on the property. A dust sample was also collected from a central vacuum system for the house (receptacle is located in the attached garage) and analyzed. All soil, water, and dust samples were analyzed to determine ²³⁸U, ²³²Th, and ²²⁶Ra concentrations.

SURVEY RESULTS

Current DOE guidelines for sites included within the FUSRAP are summarized in Table 1. Typical background radiation levels for the state of Ohio (Toledo, Ohio is 15 miles south of the Ottawa Lake, Michigan area, Fig. 1) are given in Table 2. These data are provided for comparison with survey results presented in this section. All direct measurement results presented in this report are gross readings; background radiation levels have not been subtracted. Similarly, background concentrations have not been subtracted from radionuclide concentrations in soil, water, and dust samples.

Photographs of the property at Ottawa Lake, taken in September, 1992, are shown in Figs. 2 through 7.

SURFACE RADIATION MEASUREMENTS

A general surface gamma scan was conducted outside on the entire property, except for the portion covered with underbrush and the area around the pond, and also of the inside of the house and garage. Results of the gamma scan over the property surface are shown in Fig 8. In addition, beta and discrete alpha measurements were taken indoors on all floor surfaces, and outdoors, beta scans were conducted over walks, etc. wherever possible.

Gamma Measurements

A gamma scan of all the floors inside both the house and attached garage showed an average of 8 $\mu\text{R/h}$, which is well below the DOE indoor guideline of 20 $\mu\text{R/h}$ above background (Table 1), and is comparable to background measurements for the area. (Table 2).

Outdoors, results of the gamma scan over the ground surface are shown in Fig. 8. In the vicinity of the house and lawns where no fill dirt had been placed, exposure rates generally ranged from 4 to 6 $\mu\text{R/h}$, with a maximum 12 $\mu\text{R/h}$ measured on the driveway. Radiation measurements ranged from 8 to 40 $\mu\text{R/h}$ in the "fill dirt" area southeast of the house on the edge of the existing lawn, where pockets of contaminated soil were detected (see Fig. 8). Surface contamination constitutes about 10% of this area. In the berm and pit area northwest of the house, contamination was spotty and radiation measurements ranged from 8 to 40 $\mu\text{R/h}$ over most of the area. A maximum of 120 $\mu\text{R/h}$ was measured at the soil surface on the ridge of the pile (berm). Biased soil samples were taken in all large contaminated areas (several small spots/areas were not sampled) and analyzed for radionuclide content.

Alpha Radioactivity Levels and Beta-Gamma Dose Rates Indoors

Beta-gamma dose rates and surface alpha measurements over the floor surfaces were below minimum detectable activities (MDA)*

SOIL SAMPLES

Systematic

Systematic soil samples were collected from undisturbed portions of the site as well as on the adjoining property well away from the contaminated areas. All samples were well below the background levels for the area except one (sample S1). This sample was taken on the adjoining property 30 ft north of the property line and had a ^{238}U concentration of 3.3 pCi/g, which is a little higher than the typical background levels in the area, but well below the guideline value for ^{238}U (Table 1). Soil sample locations are shown in Fig. 8 and results of analyses are listed in Table 3.

Biased

Biased soil samples were taken in the areas of elevated gamma readings that were measured where soil had been allegedly transported. These areas were to the east and south (front) of the house at the edge of the existing lawn ("fill dirt" area, Fig. 8), and to the northwest of the house where the pile of soil and the pit are located (see Introduction for description of events). Analyses showed that ^{226}Ra concentrations ranged from 0.42 to 1.3 pCi/g for both surface and subsurface soil, and from 0.27 to <0.93 pCi/g for ^{232}Th , all of which are at or below background levels for the area. Samples analyzed for ^{238}U , however, showed a range of 95 to 350 pCi/g in surface (0-15 cm) soil, with a maximum of 1900 pCi/g found in sample B6A, taken from the highest surface gamma measurement location on the berm northwest of the house. Uranium concentrations in subsurface soil (15-30, 30-45 cm below the surface) were lower and ranged from 11 to 120 pCi/g. Again, the maximum value was found in the sample taken from the berm (B6B). Soil sample locations are indicated on Fig. 8 and results of radionuclide analyses are listed in Table 3.

*The instrument-specific minimum detectable activities (MDAs) for directly measured and removable alpha radiation levels are 25 and 10 dpm/100 cm², respectively. For directly measured and removable beta-gamma radiation levels the MDAs are 0.01 mrad/h and 200 dpm/100 cm², respectively.

WATER SAMPLES

Water samples were taken from the pond north of the house at the point where run-off from the pit area entered the pond, and from a faucet outside the house. The house is supplied by a well which is ~120 ft deep. Results are listed in Table 3.

Analyses showed a ^{238}U concentration of 0.026 pCi/mL (26 pCi/L) in the sample from the pond, well below the NRC standard of 40 pCi/mL for uranium concentrations in effluents from sites intended for unrestricted use (NRC 10 CFR 20.106 Appendix B, Table II), and 0.00003 pCi/mL (.03 pCi/L) in the well water, which is also well below the proposed EPA guideline of 0.03 pCi/mL total uranium in drinking water (56FR 33050, July 18, 1991).

DUST SAMPLE

A sample of the contents of the receptacle of the vacuum system for the house was also collected and analyzed for ^{226}Ra , ^{232}Th and ^{238}U . Results of the analyses (Table 3) show concentrations of ^{226}Ra and ^{232}Th were both 0.15 pCi/g, which is much less than the typical soil background levels for these two nuclides. The maximum ^{238}U concentration of 1.3 pCi/g found in the sample is comparable to the typical background level of uranium in soil in this area (Table 2).

SIGNIFICANCE OF FINDINGS

The majority of the measurements taken during the radiological survey at 4400 Piehl Road, Ottawa Lake, Michigan indicate results that are within DOE guidelines. These guidelines ensure that unrestricted use will not result in significant exposures to anyone on the site. Isolated spots of uranium contamination were identified in surface and subsurface soil in two areas where materials from the former Baker Brothers site were allegedly placed. These areas are located to the south, northwest, and to the southeast of the house (see areas labeled as contaminated on Fig. 8).

The highest gamma reading was on the berm in the contaminated area northwest of the house, where the highest concentrations of uranium were also found in the soil. But this area is in a location that is fairly inaccessible to casual use. There is some runoff from the pit area where rainwater drains from the area to the pond, but results of the water analyses show that, although slightly elevated, no

radionuclide concentrations are above EPA guidelines. The analysis of the vacuum system contents also revealed no detectable contamination inside the house.

There does not appear to be any imminent health threat under conditions observed at the site; however, normal family activity in and around the property will involve movement in some of the contaminated areas. This could lead to further spread of the contamination and possibly migration into the house. The maximum gamma measurement was 120 $\mu\text{R/h}$ at the ground surface, but was at a location on the ridge line of the pile which is fairly inaccessible to casual use.

Uranium uptake by persons on the property by ingestion is fairly unlikely; but mechanical disturbance (grading, plowing, etc.) during dry and dusty conditions makes uptake by inhalation a possibility. Concentrations of ^{238}U found in soil samples taken from the location of the elevated gamma measurements exceed typical site-specific uranium guidelines for soil that were derived for similar DOE FUSRAP sites. Based on these findings, it is recommended that this site be considered for inclusion under FUSRAP.

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3. R. D. Foley and L. M. Floyd, *Radiological Survey of the Former Baker Brothers, Inc. Site, 2551-2555 Harleau Place, Toledo, Ohio* (BTO001), ORNL/RASA-90/8, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., March 1992.
4. T. E. Myrick, B. A. Berven, W. D. Cottrell, W. A. Goldsmith, and F. F. Haywood, *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program*, ORNL/TM-8600, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., April 1987.

Table 1. Applicable guidelines for protection against radiation
(Limits for uncontrolled areas)

Mode of exposure	Exposure conditions	Guideline value
Gamma radiation	Indoor gamma radiation level (above background)	20 $\mu\text{R}/\text{h}^a$
Total residual surface contamination ^b	²³⁸ U, ²³⁵ U, U-natural (<i>alpha emitters</i>) or Beta-gamma emitters ^c	
	Maximum	15,000 dpm/100 cm ²
	Average	5,000 dpm/100 cm ²
	Removable	1,000 dpm/100 cm ²
	²³² Th, Th-natural (<i>alpha emitters</i>) or ⁹⁰ Sr (<i>beta-gamma emitter</i>)	
	Maximum	3,000 dpm/100 cm ²
	Average	1,000 dpm/100 cm ²
	Removable	200 dpm/100 cm ²
	²²⁶ Ra, ²³⁰ Th, transuranics	
	Maximum	300 dpm/100 cm ²
	Average	100 dpm/100 cm ²
	Removable	20 dpm/100 cm ²
Beta-gamma dose rates	Surface dose rate averaged over not more than 1 m ²	0.20 mrad/h
	Maximum dose rate in any 100-cm ² area	1.0 mrad/h
Radionuclide concentrations in soil (generic)	Maximum permissible concentration of the following radionuclides in soil above background levels, averaged over a 100-m ² area ²²⁶ Ra ²³² Th ²³⁰ Th	5 pCi/g averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over 15 cm-thick soil layers > 15 cm below the surface
Derived concentrations	²³⁸ U	Site specific ^d

Table 1 (continued)

Mode of exposure	Exposure conditions	Guideline value
Guideline for non-homogeneous contamination (used in addition to the 100-m ² guideline) ^e	Applicable to locations with an area ≤ 25 m ² , with significantly elevated concentrations of radionuclides ("hot spots")	$G_A = G_i(100/A)^{1/2}$, where G_A = guideline for "hot spot" of area (A) G_i = guideline averaged over a 100-m ² area

^aThe 20 μ R/h shall comply with the basic dose limit (100 mrem/yr) when an appropriate-use scenario is considered.

^bDOE surface contamination guidelines are consistent with *NRC Guidelines for Decontamination at Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By-Product, Source, or Special Nuclear Material*, May 1987.

^cBeta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ⁹⁰Sr, ²²⁸Ra, ²²³Ra, ²²⁷Ac, ¹³³I, ¹²⁹I, ¹²⁶I, ¹²⁵I.

^dDOE guidelines for uranium are derived on a site-specific basis. Guidelines of 35-40 pCi/g have been applied at other FUSRAP sites. Sources: J. L. Marley and R. F. Carrier, *Results of the Radiological Survey at 4 Elmhurst Avenue, Colonie, New York (AL219)*, ORNL/RASA-87/117, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., February 1988; B. A. Berven et. al., *Radiological Survey of the Former Kellogg Research Facility, Jersey City, New Jersey*, DOE/EV-0005/29, ORNL-5734, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., February 1982.

^eDOE guidelines specify that every reasonable effort shall be made to identify and to remove any source that has a concentration exceeding 30 times the guideline value, irrespective of area (adapted from *Revised Guidelines for Residual Radioactive Material at FUSRAP and Remote SFMP Sites*, April 1987).

Sources: Adapted from U.S. Department of Energy, *Radiation Protection of the Public and the Environment*, DOE Order 5400.5, April 1990, and U.S. Department of Energy, *Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites*, Rev. 2, March 1987.

**Table 2. Average background radiation levels
for the Ohio area^a**

Type of radiation measurement or sample	Radiation level or radionuclide concentration
Gamma exposure at ground surface ($\mu\text{R/h}$)	8
Concentration of radionuclides in soil (pCi/g) ^b	
²²⁶ Ra	1.5
²³² Th	1.0
²³⁸ U	1.4

^aSource: T.E. Myrick, B.A. Berven, and F.F. Haywood, *State Background Radiation Levels: Results of Measurements Taken During 1975-1979*, ORNL/TM-7343, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., November 1981.

^bThese values represent the average normal radionuclide concentrations in the state of Ohio.

Table 3. Concentrations of radionuclides in soil, water, and dust samples from 4400 Piehl Road, Ottawa Lake, Michigan

from 4400 Pienl Road, Ottawa Lake, Michigan				
Sample number ^a	Depth (cm)	Radionuclide concentration (pCi/g) ^b		
		²²⁶ Ra	²³² Th	²³⁸ U
<i>Systematic samples^c</i>				
S1	0-15	0.53 ± 0.03	0.38 ± 0.04	3.3 ± 2
S2	0-15	0.37 ± 0.01	0.25 ± 0.02	0.54 ± 0.3
S3	0-15	0.26 ± 0.02	0.20 ± 0.03	0.92 ± 0.2
<i>Biased samples^d</i>				
B1A	0-15	0.77 ± 0.14	0.79 ± 0.3	350 ± 80
B1B	15-30	0.46 ± 0.08	0.32 ± 0.10	50 ± 5
B2A	0-15	0.87 ± 0.1	0.88 ± 0.1	160 ± 20
B2B	15-30	0.79 ± 0.1	0.73 ± 0.2	85 ± 20
B2C	30-45	0.42 ± 0.08	0.27 ± 0.12	20 ± 5
B3A	0-15	0.86 ± 0.09	0.63 ± 0.1	95 ± 7
B3B	15-30	0.71 ± 0.07	0.53 ± 0.1	25 ± 5
B4A	0-15	0.61 ± 0.09	0.50 ± 0.1	100± 12
B4B	15-30	0.75 ± 0.1	0.65 ± 0.2	80± 10
B4C	30-45	0.44 ± 0.08	0.29 ± 0.1	11± 2
B5A	0-15	0.80 ± 0.09	0.73 ± 0.1	120± 30
B5B	15-30	0.69 ± 0.09	<0.28	52± 3
B5C	30-45	0.66 ± 0.05	0.38 ± 0.1	11± 1
B6A	0-15	1.3 ± 0.3	<0.93	1900 ±300
B6B	15-30	0.51 ± 0.08	0.44 ± 0.1	120 ± 30

Table 3. (continued)

Sample number ^a	Radionuclide concentration (pCi/g) ^b		
	²²⁶ Ra	²³² Th	²³⁸ U

Dust sample^c

M1	0.15 ± 0.02	0.15 ± 0.03	1.3 ± 0.1
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Water samples^f

		²³⁸ U (pCi/mL)
W1	(pond)	0.026
W2	(well)	0.00003

^aLocations of soil samples are shown on Fig. 8.

^bIndicated counting error is at the 95% confidence level ($\pm 2\sigma$).

^cSystematic samples are taken at locations irrespective of gamma exposure rates.

^dBiased samples are taken from areas with elevated gamma exposure rates.

^eDust material taken from central vacuum system for the house.

^fWater samples taken from the pond and well (water supply for the house). (Uranium concentrations only).

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Fig. 1. Diagram showing general location of the property at Ottawa Lake, Michigan, relative to the former Baker Brothers site in Toledo, Ohio.

Fig. 2. View looking north toward the house from the edge of the fill area at 4400 Piehl Road, Ottawa Lake, Michigan. Broadleaf vegetation marks the south edge of the fill area.

ORNL-PHOTO 776-93

Fig. 3. View looking northwest from east edge of the filled area towards the house at 4400 Piehl Road, Ottawa Lake, Michigan.

Fig. 4. View looking northeast at the northwest corner of the house and back yard at 4400 Piehl Road, Ottawa Lake, Michigan.

Fig. 5. View of the pile and pit area (left foreground), with the pond in the background, northwest of the house at 4400 Piehl road, Ottawa Lake, Michigan.

ORNL-PHOTO 779-93

Fig. 6. View looking due west at pit and berm in the contaminated area northwest of the house at 4400 Piehl Road, Ottawa Lake, Michigan.

ORNL-PHOTO 780-93

Fig. 7. View looking due north at the pond located north of the house at 4400 Piehl Road, Ottawa Lake, Michigan.

Fig. 8. Surface gamma exposure rates and soil and water sampling locations at 4400 Piehl Road, Ottawa Lake, Michigan.

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